

Safety and Efficacy of Ureteroscopic Pneumatic Lithotripsy

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ABSTRACT

Objective: To determine the safety and efficacy of ureteroscopic pneumatic lithotripsy (PL) for the clearance of ureteral calculi (UC).

Study Design: Experimental study.

Place and Duration of Study: Department of Urology, KRL Hospital, Islamabad, from March 2006 till December 2008.

Methodology: Ureteroscopic PL was performed on 104 patients with ureteric calculus measuring ≥ 6 mm; using Swiss Lithoclast through a 9.5 French semi-rigid ureteroscope. At the end of the procedure, a DJ stent was inserted. Complications were noted. Stone clearance was assessed through X-ray KUB. DJ stent was removed within 3 - 6 weeks after the procedure.

Results: Sixty-eight patients (65.4%) were males and 36 (34.6%) females. The average hospital stay was 2.6 ± 2.8 days; 72 (69.6%) patients were discharged on the first post-procedure day. Complete stone clearance was achieved in 98 (94.2%) patients, at 3-6 weeks. Four patients (26.7% of upper ureteral stones) had stone retropulsion. The only major complication was perforation occurring in 2 (1.9%) distal ureters. One case was successfully managed by endoscopic DJ stent placement, the other required open repair.

Conclusion: Ureteroscopic PL is effective in clearing majority of middle and distal UC. Patients with proximal stones may have stone retropulsion. Ureteric perforation is an uncommon complication.

Key words: Ureteral calculi. Lithotripsy. Ureteroscopy.

INTRODUCTION

Renal stone has worldwide prevalence of between 2 and 20%.¹ Pakistan is part of the Afro-Asian stone forming belt, where the prevalence of calculi ranges from 4% to 20%.² Ureteral calculi are quite common and usually present with acute flank pain and hematuria. The rate of spontaneous passage of ureteric stones varies according to stone size; about 80% of the stones smaller than 4 mm pass spontaneously, whereas only 21% stones larger than 6 mm do so.³ Indications of surgical intervention include failure of conservative treatment, solitary obstructed kidney, intractable pain, urosepsis and patient's choice.¹

Urologic armamentarium for the treatment of ureteral calculi (UC) consists of extracorporeal shock wave lithotripsy (ESWL), ureteroscopic lithotripsy, laparoscopic ureterolithotomy and open ureterolithotomy. Treatment choice depends upon stone location, size, availability of endourological facilities and patient's preference. Retrograde ureteroscopy (URS) has become the most commonly performed procedure for UC.⁴ Antegrade URS and laparoscopic ureterolithotomy can deal with almost all types of ureteral stone disease,

obviating the need for open ureterolithotomy all together. However, open ureterolithotomy continues to be a frequently performed procedure in Pakistan due to the non-availability of endourological instruments and, therefore, lack of expertise.

There are currently several devices for intracorporeal lithotripsy, which include electrohydraulic, ultrasonic, pneumatic and laser lithotripters. Pneumatic lithotripsy (PL) was first introduced in the early 1990s.⁵ Numerous reports have been published since then, indicating very high success rates.^{6,7} However, only a small number of local studies have been published in the literature regarding the effectiveness of ureteroscopic pneumatic lithotripsy for the treatment of UC in Pakistani population.

The purpose of this study was to determine and document the effectiveness and complications of intracorporeal PL for clearance of ureteral stones in a local group of patients.

METHODOLOGY

This was an experimental study conducted at Department of Urology, KRL Hospital, Islamabad, from March 2006 till December 2008. All the patients diagnosed with ureteric stones ≥ 6 mm in diameter were included in the study. Patients presenting with ureteral stones less than 5 mm in diameter, pregnant patients or those who refused to consent were excluded.

Data was collected using standardized proforma. Pre-operative routine investigations included blood counts,

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biochemical analysis (serum urea and creatinine level) and urinalysis. Urine culture was performed if urinalysis was indicative of infection. Urinary infections were managed with culture proven antibiotics. X-ray of kidneys, ureters and urinary bladder (KUB) and ultrasonography were performed in all patients. Intravenous urography (IVU) was performed in patients presenting with hydronephrosis and/or hydroureter on ultrasonography; no radio-opaque calculus on X-ray KUB and normal serum creatinine. CT KUB was not available in our hospital at that time. Ureteroscopy was performed in all patients under general anesthesia. Pre-operative 01 gram of intravenous cefotaxime was given during induction of anesthesia. A 9.5 French semi-rigid ureteroscope (Karl Storz, Germany) was used transurethrally. For the introduction of URS into ureteric orifice, a 150 cm, 0.038 inch flexible guidewire was used, along-with compression of glycine bag. Balloon dilatation of ureteric orifice was not done. In case of difficulty in negotiating the intramural part of the ureter or kinks of the ureter, two guidewires were used (one through the URS and the other alongside). This ensured easy maneuvering without the risk of damaging the ureters.

Pneumatic lithotripsy (PL) was performed with the Swiss lithoclast (Electro Medical Systems, Switzerland) using single or multiple fire technique. This device uses a 1 mm rigid probe connected to the hand-piece that contains a small metal projectile and a foot switch. Upon activation of the device, compressed air propels the metal projectile within the hand-piece against the head of the probe at a pressure of 3 atmospheres and a frequency of 12 Hz. Repeated impact of the probe tip against the stone results in fragmentation. Stone disintegration was performed to a particle size of approximately 2-3 mm. Small fragments were allowed to pass spontaneously. At the end of the procedure, a DJ stent was inserted. DJ stent was removed within 3 - 6 weeks, postprocedure. An X-ray KUB was performed on postoperative day 1 and before stent removal (if required) to exclude residual stone fragments. DJ-stent was removed under local anesthesia on day care basis. Data was analyzed using Statistical Package for the Social Sciences (SPSS, version 11). For continuous variables like age, hospital stay in days and size of calculus, mean \pm S.D was calculated. Frequency (percentage) was calculated for categorical variables like gender, mode of presentation, stone location and stone clearance rate.

RESULTS

Patient characteristics and stone location are shown in Table I. Of the total 104 patients, 85 (81.7%) patients were admitted electively through outpatient clinic, whereas 19 (18.3%) patients were admitted through

Table I: Patient demographics and stone clearance rates.

Patient characteristics	Number of patients
Total number of patients	104
Gender distribution	
Male	68 (65.4%)
Female	36 (34.6%)
Mean age (in years)	39 \pm 9.21
Mode of presentation	
Out- patient clinic	85 (81.7%)
Emergency	19 (18.3%)
Mean stone size (in mm)	12.58 \pm 3.01
Stone location	
Upper	15 (14.4%)
Middle	23 (22.1%)
Lower	66 (63.4%)
Stone clearance rate	98 (94.2%)
Mean hospital stay (in days)	2.6 \pm 2.8

emergency. Although the average hospital stay was 2.6 days, 72 (69.6%) patients were discharged on first post-operative day.

Complete stone clearance was achieved in 98 (94.2%) patients, at 3-6 weeks as evident on X-ray KUB and/or ultrasonography. There were 04 patients having upper ureteral stones (26.7% of upper stone group) in whom stone was pushed back (retrograde displacement) into the kidney. Three patients were treated with DJ stent placement and postoperative ESWL, resulting in stone clearance. One patient underwent successful repeat PL as salvage procedure after failure of ESWL to clear the stone and stone migrating into the ureter.

Major complication was ureteric perforation in 2 (1.9%) case. These involved the distal ureter and were recognized at the time of surgery. One case was successfully managed by DJ stent placement, the other required open repair and DJ stent placement. DJ stents were subsequently removed after 6 weeks. There was no case of ureteric avulsion, stricture or urosepsis. Minor complication included postoperative self-limiting hematuria, flank pain and irritable bladder symptoms. These were effectively treated conservatively.

DISCUSSION

Endourological management of UC is continuously evolving. A variety of intracorporeal lithotripters are available, which include electrohydraulic, ultrasonic, pneumatic and laser lithotripters. Electrohydraulic lithotripsy (EHL) was one of the earliest techniques to be used for UC.⁸ The mechanism of action involves generation of a cavitation bubble leading to stone fragmentation. Stone disintegration rates of more than 90% have been reported. Tissue trauma is a significant complication of EHL.^{9,10} The use of ultrasonic (US) waves for lithotripsy was first described by Mulvaney.¹¹ The major drawback of US lithotripsy is the obligatory requirement of large diameter instruments with straight

working channels; hence it requires dilatation of the intramural part of the ureter. This substantially increases the operating time and radiation exposure to the patient.⁷

The introduction of small caliber URS and advent of intracorporeal PL and holmium:yttrium-aluminum-garnet (YAG) laser, have improved stone clearance rates and minimized complications.⁷ According to literature, the success rate of PL appears to be greater than 90%.^{6,7} In a large series reported by Puppo, the overall success rate was 93.6%.¹² The results of holmium:YAG laser lithotripsy for UC are comparable to PL, in terms of stone clearance rate.¹³ However, PL has an advantage over laser lithotripsy due to better stone targeting. Rapid light flashes emerge from the laser and obscure stone visualization.¹⁴

In this study, the success rate was 94.2%, which is in accordance with the literature.^{6,7} Four cases of upper ureteral stones had failed PL due to proximal migration of stone. The reported incidence of stone retropulsion varies from 2.0% to 3.8%.^{7,15} In an effort to prevent stone migration while performing PL, the head end of the operating table was raised by 15-20 degrees and low fluid pressure was used. Other options include use of stone cone,¹⁶ stone baskets¹⁷ and antegrade balloon occlusion catheters.¹⁸ These devices in turn increase the expenditure and are time-consuming. Zehri and co-workers have advocated the use of lidocaine jelly instillation proximal to ureteral stones to prevent stone displacement.¹⁹

Complication of PL include ureteral perforation (0 - 4.7%),¹ mucosal trauma (3.6%),²⁰ avulsion (0.06 - 0.4%),^{21,22} ureteric stricture (3.5%)¹ and urospepsis (1.8 - 3.0%),^{7,20} postoperative hematuria (1.2 - 7.3%),^{20,22} fever (5.3%)²⁰ and flank pain (18.4%).²² In this study, there were two incidents of ureteral perforations. In both these cases, there was stone impaction causing distal ureteral wall weakening. This led to perforation of the ureteral wall during PL due to manipulation difficulties. One case was managed using endourologic measures (DJ stenting alone), while the other required open repair. To avoid such intraoperative complications, it is mandatory that force should never be applied against any resistance; the ureteral lumen should be in view when the ureteroscope is advanced and guide-wires should be used for safe crossing of curves/vessels/kinks. Although the reported incidence of urospepsis is upto 3.6%, we experienced no such complication. This could be explained on the basis that routine peri-operative antibiotic cover included 3 doses of third generation cephalosporin; one pre-operatively and two postoperatively.

DJ stent was routinely placed at the end of the procedure. The placement of DJ stent ensures unobstructed urine flow from the kidney to the bladder.

Obstruction to urine flow can occur due to residual/retained stone fragment or edema of the ureteral wall. Hence DJ stents were placed in order to minimize the incidence of potential complications. Although it has been reported that with short operating time and minimal ureteral trauma, ureteral stents may not be necessary after URS.²³ Absolute indications for DJ stent placement include ureteral injury, ureteric stricture, solitary kidney, renal insufficiency or large residual stone burden.

Non-availability of CT KUB for pre-operative diagnosis and detection of postoperative clearance of radiolucent ureteric stones remains an important limitation of this study.

CONCLUSION

Ureteroscopic PL can successfully clear majority of middle and distal UC. More proximal stones may undergo retropulsion. Major complications are uncommon.

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